COMPARISON BETWEEN BACTERIOLOGICAL ANALYSIS OF AIR BY THE PLATE METHOD AND BY FILTERS.

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Two principal methods have so far been used by investigators to determine the numbers of bacteria in air: First, Petri dishes, containing a suitable culture medium, have been exposed for the organisms to settle upon during a definite period of time; and, second, the bacteria have been collected by means of filters through which a measured volume of air has been passed.

An opportunity was afforded me during a recent investigation of the air of the New York subway to compare the serviceability of these two methods on a scale and under conditions which were capable of giving a useful idea of their relative value.

The determinations by the plate method numbered about 2,800; the determinations by the filter method, 166. The work was all done in duplicate. The air examined was the air of the New York subway and the air of the streets. As far as practicable, the observations by the two methods were made under the same circumstances as to hour and place, but they were not made simultaneously.

THE PLATE METHOD.

The plates used were Petri dishes about $3\frac{1}{2}$ inches in diameter. The culture-medium was beef-extract agar. The reaction, determined by preliminary experiments to ascertain the optimum, was 1 to 1.5 per cent acid to phenolphthalein.

It was customary to pour the agar into the plates at the laboratory and incubate them for twelve hours at 37° C. before exposing them to detect accidental contamination. The plates were carried from the laboratory to the point where the air was to be examined, wrapped in sterile towels, and fitted closely into a handbag. The period of exposure was 15 minutes in those cases where the numbers of bacteria were not expected to be large.

After exposure, the plates were taken to the laboratory, incubated at 37° C., and counted after 48 hours. Moulds were distinguished from the bacteria and a separate record kept of their number.

THE FILTER METHOD.

The filter method was substantially that used by Sedgwick, Prudden, and others, with some modifications. The filters were glass tubes about 0.5 c.c. inside diameter, and 13 cm. long. The filtering material was held in place by a plug of wire gauze at one end and at the other freely exposed to the air. During transportation a plug of sterilized cotton closed the tube at each end.

After preliminary trials of various filtering materials, including some soluble ones, the medium finally adopted was sand. The depth of sand was about 5 cm. The particles were chiefly quartz. The grains ranged from about 1 mm. in diameter down to very fine particles. Two filters were always arranged in tandem.

Air was passed through the filters in most cases by means of a carefully constructed air pump. The quantity of air was determined by the number of strokes of the pump. To pump 20 liters of air through the filters, 66 strokes were required. This was the amount generally used in each case.

It was sometimes not feasible to use an air pump, where its use would attract a crowd of curious people. Under these circumstances, a brass vacuum cylinder of about 10 liters capacity, fitted with a pressure gauge and suitable stop cocks, as devised by Prudden, was employed. This cylinder was fitted into an inconspicuous leather handbag. Through suitable openings the gauge could be seen and the stop-cocks operated. Before taking a sample, the air was exhausted from the cylinder and the stop-cocks closed. The apparatus was then carried to the place where the observation was to be made. The filters were there connected to the cylinder by means of short rubber tubes and, after reading the gauge, the air was allowed to flow into the cylinder through the filters. The cocks were closed when the desired quantity of air had been filtered, as determined by a second reading of the gauge. Finally, the filters were replugged and taken to the laboratory.

At the laboratory the sand was emptied from the first filter into a test-tube which contained 10 c.c. of sterile water. After thoroughly agitating the sand and water, the organisms which were rinsed from the sand were plated in agar of similar composition to that already described as having been used in the filter method. The agar was

incubated for 48 hours at 37° C. and the colonies counted, moulds being recorded separately.

Most of the organisms were caught in the first filter. The percentage which those in the second filter bore to those in the first, as determined by 140 analyses, was 2.6.

RESULTS AND CONCLUSIONS.

As determined by the plate method and by the filter method, the same relation appeared to exist between the bacteria in the air of the subway and in the streets. The average numbers of bacteria which settled from the air in 15 minutes and were subsequently enumerated by the plate method were, in the subway, 500; in the streets, 1,157; ratio 1 to 2.3. The average numbers of bacteria found by the filter method were, in the subway, 3,200 per cubic meter of air; in the streets, 6,500; ratio 1 to 2.0.

This interesting relation between the results of examinations of the air of the subway and streets by the two methods should not be taken to indicate that both methods were accurate, for, as is well known, there is no precise way to determine the numbers of bacteria in air. The two methods were the most accurate which it was found feasible to employ upon the scale required. The plate method was very much more convenient than the filter method, and gave results which in this case were sufficiently instructive to warrant its almost exclusive employment as a general routine procedure. The filter method, although it probably gave a more accurate idea of the condition of the air, involved more difficulties of technique than the superiority of its results warranted. Together the two methods yielded data from which a large number of profitable deductions were drawn.